

Remarks

The following comments are provided in support of the claims presented. Applicants respectfully request reconsideration of the claims and entry of the amendments presented herein.

**1. § 112 Rejections**

Claim 4 has been rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. Specifically, the Office cites the phrase “metal layer” in Claim 4 as lacking antecedent basis and being indefinite for failing to refer to aluminum.

Applicants have herein amended Claim 4 to recite “the metal layer including aluminum” thereby overcoming the § 112 rejection of Claim 4.

**2. § 103 Rejections**

Claims 1 and 4-9 have been rejected under 35 USC §103(a) as being obvious over Liaw et al (US 6,605,230) in view of Smith et al (US 6,479,395) and Gennissen (“Sacrificial Oxide Etching Compatible with Aluminum Metallization”).

In paper no. 20040310, pages 3 and 4, the Office states that Liaw and Smith both perform etching of SiO<sub>2</sub> or glass using mixtures of HF and H<sub>2</sub>SO<sub>4</sub>, but fail to disclose the presence of an aluminum layer in the devices being etched. The Office then cites Gennissen for teaching a semiconductor device having an aluminum layer and states that it would have been obvious to one skilled in the art to modify Liaw and Smith in view of Gennissen by using an aluminum layer since it can be used as an interconnect layer.

Applicants respectfully submit that, based on this combination of references set forth by the Office, there would be no reasonable expectation of success for one skilled in the art to form Applicants’ invention as recited in amended Claim 1.

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Gennissen discloses an etching solution that does not include  $\text{H}_2\text{SO}_4$  for etching a sacrificial oxide without attacking the aluminum. Liaw and Smith each disclose an etching solution containing  $\text{H}_2\text{SO}_4$  for etching devices which the Office states “fail to disclose the present of the aluminum layer in the semiconductor device” (page 4 of paper no. 20040310). How then would one skilled in the art know whether or not a metal layer including aluminum in a device would be retained and not chemically attacked by exposure to an etching solution comprising  $\text{H}_2\text{SO}_4$  and HF as recited in Claim 1? The answer to this question cannot be found in the art of record, but only from Applicants’ disclosure. Without any information in the art of record about whether or not aluminum would be attacked by exposure to an etching mixture containing  $\text{H}_2\text{SO}_4$ , Applicants respectfully submit that one skilled in the art would not be motivated to utilize an etching solution containing  $\text{H}_2\text{SO}_4$  and HF as disclosed by Liaw and Smith with a device containing aluminum as disclosed by Gennissen since there would be no way to know whether or not the aluminum would be retained or attacked by the  $\text{H}_2\text{SO}_4$ . Therefore, Applicants respectfully submit that the Office has not made a valid *prima facie* case of obviousness for the rejection of Claims 1 and 4-9 based on the art of record.

Furthermore, Applicants respectfully submit that there is nothing in the art of record that would motivate one skilled in the art to combine Gennissen with Liaw and Smith. Gennissen discloses an etching mixture of HF and isopropyl alcohol (IPA) which is fully functional for etching a sacrificial oxide without attacking an aluminum interconnect layer. One skilled in the art would not be motivated to modify the fully functional etching mixture of Gennissen by substituting  $\text{H}_2\text{SO}_4$  for IPA since there is no need to do so and since the results would be uncertain given that the Office admits that “Liaw and Smith fail to disclose the present of the aluminum layer in the semiconductor device.” Gennissen further states “Especially when aluminum is used as the interconnect layer it is difficult to selectively etch the sacrificial oxide without attacking the aluminum.” (Introduction on page 225). This statement by Gennissen would further deter one skilled in the art from substituting

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other acids such as  $\text{H}_2\text{SO}_4$  for IPA since there is no information about the reactivity of aluminum with  $\text{H}_2\text{SO}_4$  in the art of record so that there would be no reasonable expectation for success in substituting  $\text{H}_2\text{SO}_4$  for IPA. Therefore, Applicants urge that the Office has not made a valid *prima facie* case of obviousness for the rejection of Claims 1 and 4-9 so that these claims are allowable.

Applicants respectfully submit that the motivation provided by the Office on page 4 of paper no. 20040310: "It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Liaw and Smith in view of Gennissen by using a aluminum layer because it can be used as an interconnection layer." is insufficient to form a valid *prima facie* case of obviousness since this motivation does not address whether or not the aluminum layer would be retained after etching with the mixture of HF and  $\text{H}_2\text{SO}_4$  as required by amended Claim 1. The above statement by Gennissen indicates the difficulty in etching a sacrificial oxide without attacking aluminum. Therefore one skilled in the art would need to understand whether or not aluminum would be attacked by  $\text{H}_2\text{SO}_4$  before modifying Liaw and Smith in view of Gennissen. Thus, given the statement by the Office "Liaw and Smith fail to disclose the present of the aluminum layer in the semiconductor device." and the statement by Gennissen that "it is difficult to selectively etch the sacrificial oxide without attacking the aluminum," Applicants respectfully submit that one skilled in the art would not be motivated to deviate from the successful etching mixture of Gennissen and adopt the mixtures of Liaw and Smith containing HF and  $\text{H}_2\text{SO}_4$ . Applicants further respectfully submit that the Office has not provided the requisite motivation needed to support a valid *prima facie* case of obviousness for the § 103 rejection of Claims 1 and 4-9 so that these claims are allowable.

Applicants further respectfully traverse the statement by the Office on page 6 of paper no. 20040310 that "Gennissen teaches to use water in the etching solution." The reaction equations in col. 2 of page 225 show that water is a reaction by-product of etching aluminum in the presence of hydronium ions ( $\text{H}_3\text{O}^+$ ) and for etching of

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SiO<sub>2</sub> by HF. This, however, does not indicate that water is present in the initial etching mixture. Gennissen states in col. 1 of page 226 "In order to lower the etch rate to lower the surface tension without a high increase in the H<sub>3</sub>O<sup>+</sup> concentration the HF was diluted with various parts of IPA." This shows that IPA was used instead of water to dilute the 73% HF. In the 40% HF concentrations, water is presumably present as indicated in col. 2 on page 226. However, Gennissen still dilute these etch solutions with IPA instead of water (see Table 2 on page 226) due to a preference of IPA over water. Table 2 also shows that the selectivity for etching the sacrificial oxide relative to etching of aluminum is reduced significantly for the 40% HF concentrations containing water which increases the H<sub>3</sub>O<sup>+</sup> concentration thereby etching the aluminum. From Gennissen, Applicants urge that one skilled in the art would understand that water is not preferred in order to achieve a high etch selectivity relative to aluminum, and therefore would not look to combine Gennissen with Smith who requires water to be present in a range from 50 - 95% (see col. 7, lines 28-33). Applicants urge that Gennissen and Smith are contrary since Gennissen teaches that a low water content is necessary to reduce the etching of aluminum and to provide a high selectivity for etching the sacrificial oxide relative to aluminum; whereas Smith teaches the use of an etching mixture containing a high water content. The contrary teachings and requirements of Gennissen and Smith are evidence for the *prima facie* unobviousness of the combination of Liaw, Smith and Gennissen set forth by the Office. Therefore, Claims 1 and 4-9 are allowable.

With regard to Claim 4, the Office cites Gennissen for disclosing an etch selectivity for the oxide sacrificial material relative to the metal layer including aluminum that is from 40 to 680 which is within the range of "greater than 100" recited in this claim. Applicants respectfully submit that the etch selectivity numbers, which the Office apparently takes from Table 3 on page 227 of Gennissen, are for several different types of etching mixtures all without H<sub>2</sub>SO<sub>4</sub> contrary to the requirement of Claim 4 which requires an etching solution including H<sub>2</sub>SO<sub>4</sub>. Therefore, Applicants submit that it would be completely uncertain to one skilled in

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the art what the etch selectivity would be for a mixture of HF and H<sub>2</sub>SO<sub>4</sub> as required by Claim 4 since the “etch selectivity for the sacrificial oxide sacrificial material relative to the metal layer including aluminum” is nowhere addressed by Gennissen, Liaw or Smith. The process of conducting routine experiments so as to produce an expected result cannot occur when there is nothing in the art of record that teaches or suggests that the etch selectivity of aluminum should be considered in an etching mixture of HF and H<sub>2</sub>SO<sub>4</sub> as recited in Claim 4. Furthermore, there is nothing in the art of record that teaches or suggests that an etch selectivity “of greater than 100” could be attained as required by Claim 4. Therefore, Applicants respectfully submit that the Office has not made a valid *prima facie* case of obviousness for the rejection of Claim 4 so that this claim is allowable.

With regard to Claim 6, the Office states that Liaw teaches to etch the SiO<sub>2</sub> material at 0-140 °C which encompasses Applicants range of 5-70 °C. Applicants respectfully submit that the reference to “00” in Liaw in col. 2, lines 58-59 “temperature at 00-140 °C (preferably 120 °C)” would be understood by one skilled in the art to be a typographical mistake which should correctly be “100” since immediately above this passage in col. 2, lines 48-49 Liaw states “temperature 100-140 °C., preferably 120 °C.” Therefore, one skilled in the art would understand that the range disclosed by Liaw (100 - 140 °C) is outside the range recited by Applicants in Claim 6. Therefore, Applicants respectfully submit that the Office has not made a valid *prima facie* case of obviousness for the rejection of Claim 6 so that this claim is allowable.

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Conclusion

Applicants have responded to each and every rejection and objection, and urge that the Application is in condition for allowance. A favorable reconsideration and entry of the amendments presented herein is earnestly solicited as being necessary to place the application in condition for allowance or appeal.

Respectfully submitted,

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